claim 1 or 2 wherein said tubular member and said wall member extend inwardly from a common flange encircling said tubular member and wall member for mounting to said combustion chamber.

4. A cooled air inlet tube according to claim 1, 2 or 3 wherein said wall member is integrally attached to said tubular member on generally opposite sides thereof.

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GB 1514449
GB 1271814
GB 1037955
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(54) Cooled air inlet tube for a gas turbine combustor

(57) The tube (22), which directs combustion air to the primary zone of a gas turbine combustion chamber, has a stepped configuration defined by a shortened wall (40) spaced outwardly from the downstream facing wall (38) of the main air inlet tube (34) to provide a slot (36) for directing a layer of air over the inwardly projecting downstream wall of the tube to protect this portion and the vulnerable downsteam edge of the tube from contact with the hot gases in the combustion chamber.

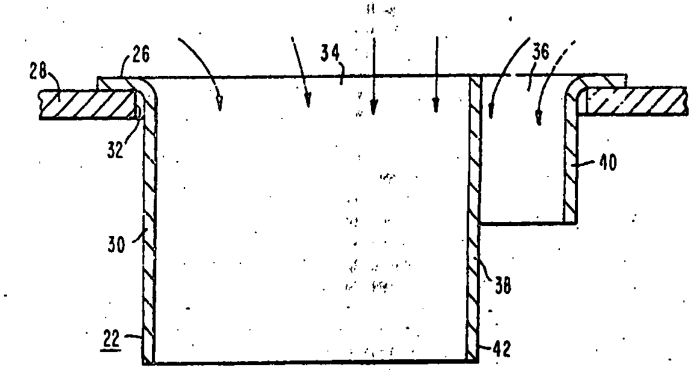

FIG. 3

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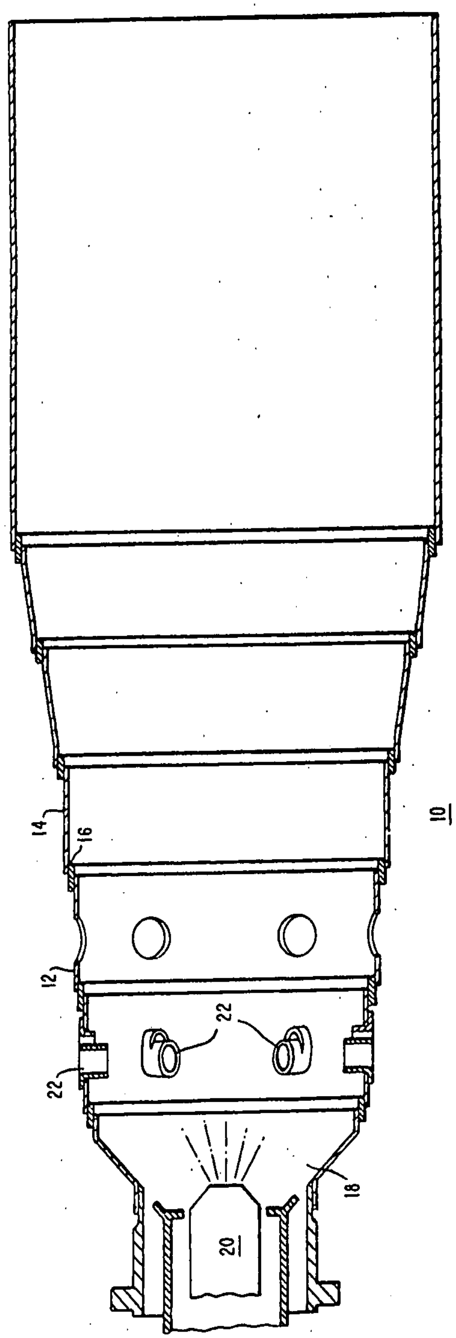

FIG. 1

2/2

2003989

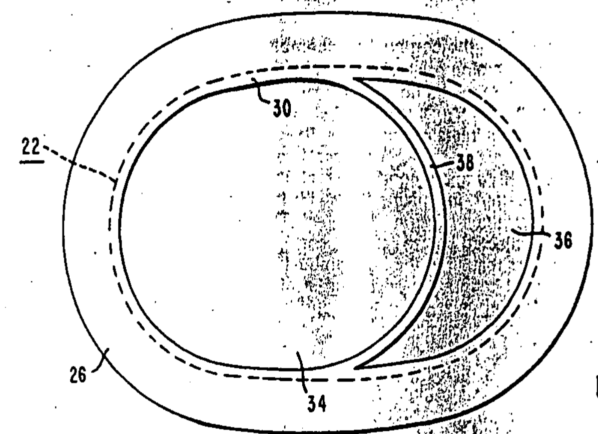

FIG. 2

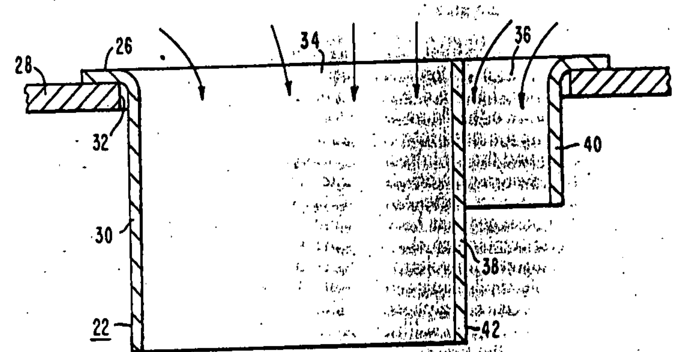

FIG. 3

SPECIFICATION

Cooled air inlet tube for a gas turbine combustor

This invention relates to the air inlet tubes for the combustion chamber of a gas turbine engine and more particularly to a film-cooled air inlet tube.

Air inlet tubes for the combustion chamber of a gas turbine engine are well known in the prior art with reference being specifically made to U.S. Patent No. 3,899,882 showing such structure. The inlets are normally disposed in annular arrays through the combustion chamber wall to inject combustion air into the fuel spray pattern for mixing therewith to promote complete combustion of the fuel. The result of this projected length into the combustion chamber results in the hot combustion gases, having a temperature on the order of 2,000 + °F, flowing over the exterior surface of the tubes, and inducing wakes adjacent the downstream facing wall of each tube. These wakes are generally referred to as "hot wakes" and result in a region of high temperature gases intimately contacting this downstream facing wall of the tube. Further, radiation from the combustion flame is received directly on this downstream facing wall of the tube to add to the temperature thereof. Due to these conditions, the air inlet tube quite often becomes overheated and, generally starting at the inlet edge of the downstream wall, which is the most vulnerable area to the heat, becomes burned out.

Thus, heretofore, the inlet tubes were made sufficiently short so as to keep the most vulnerable portion, i.e. the downstream edge, as far removed from the flame front as possible and still obtain a good intermixing between the fuel and the air introduced through the tube. However, recent developments in a gas turbine combustor particularly directed to adapting it to burn coal gas have resulted in larger diameter combustion chambers (necessitated by an increase in volume of the combustors to obtain similar operating results. In such larger combustor chambers, the short air inlet tubes do not provide sufficient penetration of the air into the fuel such that there are pockets of unburned fuel resulting in smoke. To prevent this smoke, the inlet tubes by necessity are required to extend further into the chamber which in turn places the downstream face and particularly the downstream edge closer to the actual combustion flame, resulting in overheating of the tubes so that burnout occurs quite often.

The previously identified U.S. patent, although directed to cooling the internal walls of the combustion chamber in generally the same zone of the chamber as the inlet tubes, did so by permitting a portion of the air to enter through a gap in the mounting arrangement of the tubes to ultimately form a film of cooling air along the internal combustor walls. It is therein also stated that this cooling air, entering adjacent the tubes would also prevent the combustion flame from attaching itself to the downstream side of the inlet tube and thereby reduce the incidence of burnout. However, the structure therein described does not direct the air to penetrate inwardly far enough to protect the downstream edge of the tube, which in the coal gas combustor is even further from this wall cooling air and closer to the actual combustion flame.

It is, therefore, an object of this invention to provide an improved cooled air inlet tube for a gas turbine combustor with a view to overcoming the deficiencies of the prior art.

The invention resides in an air inlet tube for a combustion chamber of a gas turbine engine for directing combustion air into said chamber in a direction generally transverse to the flow of combuston products through said chamber, said tube comprising: a tubular member extending generally radially into said chamber from an aperture therein and having a downstream facing wall with respect to the flow of said combustion products; and a short wall member spaced from but adjacent to said downstream facing wall of said tube and extending from said aperture radially inwardly a distance substantially shorter than said tubular member to define a slot between the downstream facing wall of said tubular member and said wall member to direct a film of air over said downstream facing wall of said tubular member to reduce contact between said downstream facing wall and hot gases in said chamber and thereby prevent burnout of said tubular member.

The invention will become readily apparent from the following description of an exemplary embodiment thereof when read in conjunction with the accompanying drawings, in which:

Figure 2 is a schematic view of a gas turbine combustion chamber having air inlet tubes projecting therethrough;

Figure 2 is an enlarged sectional view of an air inlet tube of the present invention; and

Figure 3 is a view looking down on the inlet tube of Fig. 2.

Referring to Fig. 1, a gas turbine combustion chamber 10 is schematically shown which comprises a stepped cylindrical configuration, as is well known in the art, with each successive cylindrical portion 12, 14, being larger and connected to the adjacent upstream cylindrical portion in spaced relation as through a wiggle strip 16 to permit cooling air entry along the walls of the chamber. Fuel is introduced at the upstream end 18 of the chamber through a fuel nozzle 20 providing an atomized fuel spray pattern. Combustion air is injected into the fuel spray through an annular array of air scoops or air inlet tubes

22 projecting into the combustion chamber transverse to the flow of fuel and the combustion gases through the chamber to provide sufficient penetration of the air into the fuel spray for complete combustion of the fuel in the primary or flame zone of the chambr.

The resulting combustion, once ignited by a spark igniter (not shown), is continuous, resulting in a flow of hot gases across the surface of the air inlet tubes 22. This flow results in "hot wakes" or relatively slowly moving hot gases adjacent the downstream facing portion of the tubes 22. These hot gases come in intimate heat transfer contact with the downstream surfaces of the tubes to cause this portion to become hotter than the upstream surface of the tube. Further, this downstream facing wall, in addition to being the portion of the tube closest to the actual combustion flame and thus contacted by the hot combustion gases, also directly receives radiation from the flame, with the resulting heat absorbed by this portion of the tube causing the tube to overheat and burn out. This burnout starts at the vulnerable downstream innermost edge of the tube and generally proceeds until the tube requires replacement.

As previously stated, the overheating is particularly critical as the tube length increases to obtain sufficient air penetration in enlarged diameter combustion chambers particularly suited for low BTU fuels such as coal gas. To prevent the burnout of the air inlet tubes, a film cooling slot is provided adjacent the downstream face of the tube to direct a layer of air to flow over the downstream surface and prevent the hot gases in the combustion chamber from intimately contacting such surface. With such intimate heat transfer contact prevented, the tube is able to normally withstand the temperature increase caused by the heat absorbed from the other sources without any burnout.

Thus, referring to Figs. 2 and 3, the inlet tube 22 according to the present invention comprises an annular flange 26 for attachment, as by welding, to the wall 28 of the combustion chamber, with the main air flow tube 30 projecting radially inwardly through an aperture 32 in the wall.

The inlet opening through the flange 26 is larger than the outside diameter of the main tube 30 to provide a gap or slot 36 between the downstream facing wall 38 of the main air tube 30 and a shortened wall 40. The radially inwardly extending shortened wall 40, having an arcuate configuration conforming to the outer periphery of the opening 34 with the opposed terminal ends thereof attached to the side of the main air flow tube 30, defines the inwardly extending cooling air inlet 36 that directs a layer of film of cooling air to flow over the downstream face 38 of the tube 30 with sufficient radial penetration to flow along the complete length of the tube 30 to the innermost end 42 thereof and thereby minimize heat transfer from the hot gases within the chamber to the downstream wall of the air inlet tube. It is seen from Fig. 2 that the opening 34 and tube 30 are generally elliptical with the major axis in alignment with the direction of hot gas flow through the chamber to minimize the downstream surface 38; however, any configuration would also be enhanced by the cooling air slot 36.

It is apparent that the gap opening 36 and the radial length of the shortened wall 40 dimensions which may vary according to the various parameters such as differential in pressures between inner and outer wall, the length of the main air flow tube 30, the temperature within the combustion chamber, and the desired maximum temperature of the downstream face 38 of the tube 30, along with other considerations which may vary for each particular engine or application. However, for the most part, the desired effect is a layer of cooling air directed over the downstream facing wall of the inwardly projecting air tube to prevent burnout which generally starts at the downstream terminal edge of the tube. It is also apparent that a cooled air inlet tube as above described could be disposed at any of various positions within the combustion chamber when air penetration is required (i.e. as downstream dilution air) and where burnout of the tube ends may be a potential problem due to increased temperatures within the chamber.

CLAIMS

1. An air inlet tube for a combustion chamber of a gas turbine engine for directing combustion air into said chamber in a direction generally transverse to the flow of combustion products through said chamber, said tube comprising: a tubular member extending generally radially into said chamber from an aperture therein and having a downstream facing wall with respect to the flow of said combustion products; and a short wall member spaced from but adjacent to said downstream facing wall of said tube and extending from said aperture radially inwardly a distance substantially shorter than said tubular member to define a slot between the downstream facing wall of said tubular member and said wall member to direct a film of air over said downstream facing wall of said tubular member to reduce contact between said downstream facing wall and hot gases in said chamber and thereby prevent burnout of said tubular member.

2. A cooled air inlet tube according to claim 1 wherein the length of said tubular member is sufficient to dispose the inner end thereof closely adjacent the combustion flame within the combustion chamber.

3. A cooled air inlet tube according to